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Some Popular Misconceptions About Lubricating Grease

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One of the functions of the NLGI should be to present to Industry, those who use grease and especially those concerned with writing the specifications of large purchasing organizations, the true facts concerning their products. These persons naturally look to our association for such information.

That there is a need for dissemination of this information is evidenced by the fact that many existing specifications contain clauses whose very presence show that the writers held, to a greater or less degree, conceptions as to the functions of greases and their proper composition which are open to question.

Many of the statements which follow are old and almost axiomatic to the experienced grease maker, yet it is apparent that they need to be given more emphasis.

On the other hand, I may be mistaken in a statement here and there, in which case a free and thorough discussion is in order.

This paper is presented, not in criticism of any individuals or groups but for the purpose of emphasizing important facts concerning the composition and use of grease, and in the hope of being helpful. Perhaps it can serve as a guide towards the attitude our members should take in their contacts with the public, to the end that the status of the grease industry will be improved.

The following statements should be emphasized to those who use or buy grease lubricants:

1—Soap is a desirable, not an undesirable, component of grease.

2—There is no advantage to the user in stipulating that the percentage of oil in a given grease should exceed any certain figure.

3—The percentage of ash resulting from the combustion of a grease is not in itself an indication of quality. It should be superceded by a limitation of the percentage of uncombined mineral matter.

4—There is no necessity for limiting the percentage of water in a calcium soap grease; it is only the uncombined water which should be restricted.

5—Although excessive sweating of free oil from a grease is obviously bad, it does not follow that the best grease is the one which sweats oil the least.

6—A determination of dropping point or melting point does not indicate that a given grease may be safely used at or near this temperature.

7—The lubricating ability of a grease is not limited by that of the oil from which it was made.

(1) *Soap is a desirable, not an undesirable, Component of Greases.*

The belief that soap is not a good thing in a lubricating grease and that it would be better to make "pure mineral" greases without soap, still seems to be latent in some persons' minds, although soap greases are now generally accepted as standard and as being much superior to pure mineral greases. The latter term can include only petrolatum, paraffine wax and asphalts.

The fear that soap will separate out and cause gumming is a natural one to a person with a hard cake of washing soap in mind as a typical soap whereas in reality the soaps in greases are present as jellies, much different from regular washing soap. The nomenclature is unfortunate, but it survives because it is much more convenient to say "soap" than "the fatty acid esters of alkali metals". The important safeguard against trouble from the use of soap lies in the proper selection of the type of soap to fit the conditions of usage, and of course, proper manufacture. The manufacturing procedures which are customary at present in the grease making industry are such that troubles in service due to the presence of soap are negligible.

As to the amount of soap, the presence in a specification of limits for the ASTM penetration of the worked grease will give sufficient control. The percentage of soap for a given consistency does vary to a certain extent with the nature of the fat used, but in general, too little soap will make too soft a grease, too much will make it too stiff and too expensive to manufacture.

It is conceivable that, by special manipulation of the cooling conditions, a grease could be made to the prescribed worked consistency with so little soap as to give definitely poor service in one way or another, but I know of no such case outside a laboratory.

We thus conclude that no advantage is gained by excluding the presence of soap or limiting the range of percentage used.

(2) *Oil Content*

There is no advantage in stipulating the minimum percentage of oil in a given grease. This follows as a natural conclusion from the foregoing paragraph. It must be stated definitely, however, because many

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Barium Grease

By L. W. McLENNAN

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(Continued from March Issue)

The low temperature properties of a barium grease, as for other greases, is dependent to a considerable degree upon the viscosity and the viscosity index of the oil with which it is made. From Table 1, it is evident that at low temperatures, barium soap greases harden in the same manner as calcium or sodium greases containing oils of similar quality. By using oil of appropriately low viscosity and of high viscosity index, it has been possible to prepare a barium soap grease which lubricates effectively at bearing temperatures of approximately $-40°F$.

The stability of barium soap grease, in relation to syneresis of the grease in storage or in use, is a question of importance to manufacturer and user alike. Reasonable care in the formulation manufacture of these greases has resulted in the regular production of stable lubricants equal in quality to the commonly marketed aluminum, calcium and sodium greases, as judged by a modified Herschel test [4] or by other bleeding tests, such as that described in the Navy Department Specification 14L5. A sample of the initial commercial production of barium grease, after being stored in the original container for six years, is still entirely free from evidence of syneresis.

Extensive ball bearing tests on barium soap greases and other common type greases in the Navy Grease Machine and also in a refrigerated laboratory bearing tester have permitted a careful comparison of the bearing performances of the greases in question. The results of these tests are in general agreement with experience in using the greases under actual service conditions. Where bearing speeds, temperatures and loads are moderate, the sodium, calcium and barium greases all appear to provide satisfactory service, with the use of the barium soap grease resulting in excellent grease retention, grease seals, running torques, and bearing temperatures. At elevated temperatures (e.g. 175-225°F.) where, as far as is known among the regularly marketed greases, only the sodium and barium greases can function effectively, these two greases perform in a generally comparable manner in respect to grease retention, grease residues, grease seals, torque values, bearing temperatures, and the absence of aeration. Where bearing temperatures run considerably in excess of 225-250°F. or where bearing speeds exceed 3600 r.p.m. at elevated temperatures, certain carefully selected sodium soap greases furnish more effective lubrication. If, however, moisture can come into contact with the grease, then the barium soap grease will prove superior to the sodium grease and, in fact, will possibly be the only satisfactory grease available for use under such conditions. This combination of water resistance and a relatively high degree of heat resistance has proved singularly useful in lubricating bearings where the effects of heat, humidity, and mechanical working conjointly have resulted in an unusually difficult lubrication problem.

The tendency of greases to aerate badly in service, particularly in high speed bearings, is considered detrimental in that the aerated grease more readily leaks from a bearing and, under particularly severe conditions, it is probable that accelerated oxidation also results. Barium soap greases, as in the case of the sodium greases, appear to be relatively free from this objectionable property.

The present commercial barium greases exhibit an unusual tenacity or adhesiveness for metal surfaces and highly resist the displacing action of water. Consequently they have been found effective as rust preventives where metal surfaces, e.g. bearing surfaces, steel plates, etc., may be exposed continuously to moisture or salt water.

THE USES OF COMPLEX BARIUM SOAP GREASES

It will be evident from the foregoing description of the preparation and properties of greases containing complex barium soaps that the peculiar virtue of this type of lubricant resides principally in the following combination of properties:

1. A high degree of resistance of the deteriorating effect of water.
2. The ability to maintain a good grease structure upon exposure to high temperatures.
3. The property of maintaining grease structure under severe mechanical working.
4. An unusual adhesiveness, compared with many other common type greases of similar composition, for metal surfaces.

This unusual combination of properties qualifies the grease as an all-purpose lubricant capable of fulfilling a wide variety of highly specialized services. However, because the present commercial greases have been formulated as all-purpose lubricants and because the possibilities of the available experimental products have not been thoroughly exploited as yet, the full potentialities of the complex barium greases are not completely known at this time. New and interesting applications for the greases are continually being found.

The present commercial barium greases have been used for many purposes of lubrication where in each instance the more conventional type greases could be applied at least equally well, as for example on chassis bearings, wheel bearings, water pumps, motor bearings, track rollers, and the like. However, none of these conventional greases can be effectively used as a general-purpose lubricant for all the aforementioned services. As far as is known, barium grease is the only widely established commercial product that will serve efficiently as a single all-purpose grease. At the present time, for example, a number of the large trucking companies throughout the Pacific Coast states are using the grease as a general-purpose all-season lubricant on truck chassis, wheel bearings, water pumps, etc. These trucks operate over one of the most mountainous regions of the United States throughout the entire year. Consequently the equipment is exposed to a wide range of temperature and humidity. Another example of similar use is the case of a Southern California utility company that employs the grease as a general lubricant on the wheel bearings, chassis, water pumps, and track rollers of a fleet of 300 units which operate in low and high atmospheric temperatures, on the desert and in the mountains.

Many mining companies throughout the Western states employ the grease on much of their equipment because such equipment is being exposed in an intermittent manner to all conditions of weather and to high temperatures in the vicinity of the furnaces. Specifically, barium greases have been used for the lubrication of bearings on conveyors, cars, shaker equipment, roasters, motors, classifiers, crushers, cranes, tuggers, cable drums, etc. On a number of occasions, the use of a single grade of grease has permitted dispensing with as many as five different greases previously used to provide the same

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GEORGE W. MILLER .... *Editor*

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service. An outstanding performance of this grease occurred at a Nevada smelter of one of the major copper companies. The problem involved the lubrication of bearings on a conveyor moving blister copper from the furnace to the cooler. Because of the heat from the copper slabs, the steam and moisture attendant to the dousing of the slab for cooling, and the operation of a section of the conveyor under water at 200°F., satisfactory lubrication of the equipment presented a difficult problem. Of the 32 greases tested, barium grease was the only one found satisfactory for the purpose. Lubrication costs were cut to one-quarter and the frequency of lubrication reduced from twice daily to once every four days.

Dredging companies, irrigation districts, and flood control organizations frequently encounter severe lubricating problems with their equipment, including drag lines, water pumps, drive shafts, bucket ladders, cable drums, tractors, etc. Complications arise because many of the bearings operating at high temperatures are periodically exposed to moisture on account of the nature of the operations or of the weather. Barium grease provides adequate lubrication under these conditions. At the same time, the grease also fully protects the bearing surfaces on the above equipment against corrosion by water and against abrasion by the sand or dust that is constantly present. Still another important advantage consists in the fact that only one grease, instead of four or five, is needed by an operator for lubricating his equipment.

In the plants of the packing or canning companies, the versatility of barium grease has been utilized in a valuable manner. It is a necessary practice in these plants to clean the equipment thoroughly at regular intervals during each operating day with water, steam, and detergent. In addition, many of the bearings on the machines operate at 175-200°F. and low speeds in a wet atmosphere, or at slightly lower temperatures and high speeds in a humid atmosphere. Under these conditions, it is essential that the lubricant used in the bearings be both water- and heat-resistant and protect the bearing surfaces against corrosion, and that it should not be displaced from the bearing during the regular washing down operation with steam, water, and detergent. Furthermore, in some of the plants, as for example the Hawaiian units operating on pineapple pack, the severely corrosive action of certain fruit juices has always been a matter of major concern, and any grease that offers exceptional protection against corrosion is of unquestionable value to the trade. In all of the foregoing services, barium grease has been used with highly gratifying results.

One of the more impressive uses of the barium grease to date has been the lubrication of the roller bearings on a 9.6-mile long conveyor system for moving aggregate at Shasta Dam near Redding, California. On the main conveyor and plant lines there are in all approximately 85,000 bearings. Much of the equipment, including the conveyor, is exposed to atmospheric temperatures ranging from 10°F. to 130°F. throughout the year, and the rainfall at times during the winter months is very heavy. In addition, dust and sand are always present in the vicinity of the bearings. During the past 3½ years, these bearings have been satisfactorily lubricated with one of the present commercial barium greases.

At the new Fontana steel mill, the flexible use of barium grease has considerably simplified the problem of lubrication. The equipment is typical of that used generally throughout this industry and includes several miles of conveying system, coke and skip cars, pusher machines, mud guns, door machines, cranes, shaker screens, etc.

Certain well-known patented line-savers and wire line turn-back apparatus used to prevent excessive wear of wire lines from whipping, crawling, and overlapping, require a bearing lubricant that will withstand water, high temperature, and heavy mechanical working. The laboratory test used in selecting a suitable lubricant is a very severe one and consists essentially in running the grease in a unit roller set at 4250 r.p.m. continuously until failure occurs. Barium greases outlasted all others by many months and was selected ultimately for this type of service. This equipment is distributed world-wide, and since there is no provision for relubricating the bearings, which are packed for the life of the apparatus, successful lubrication of the apparatus is of paramount importance.

In respect to the protection of metal surfaces against corrosion, barium grease has been successfully used on flat steel and boiler plate in supply yards and for the protection of the steel parts of towers, bridges, etc., against moist air, salt water spray, and the direct impact of ocean waves. A protective agent of this sort is readily applied and can be safely removed in case welding or cutting operations are subsequently required, as for example on stored boiler plates. This grease has also been used to lubricate the governor control vanes regulating water flow to turbines; calcium greases used on the same equipment were displaced by water with eventual corrosion of the bearing surfaces. Similarly when used on the crankshafts and crank pins of certain type locomotives, barium grease withstood the effects of temperature and steam condensate with a resultant lowering in operating temperatures and protection of the bearing surfaces against corrosion.

To the foregoing examples one might add numerous instances in which barium greases have been used with equally satisfactory results: in the shipyards, in rubber mills, in paper mills, in magnesium plants, in lumber mills, and in various other industrial plants on the Pacific Coast. All of these, however, would merely serve to demonstrate that the performance of this type of grease under service conditions closely conforms with that which one might reasonably anticipate from a full knowledge of its manufacture and properties.

FUTURE POSSIBILITIES OF BARIUM SOAP GREASES

The possibilities in respect to the further development and use of barium soap greases may be viewed with distinct optimism. During the past six years, the amount of barium grease marketed by one Pacific Coast oil company has steadily increased until at the present time only the tractor and chassis lubricants surpass it in sales volume. It is anticipated that additional commercial barium soap greases will eventually be available for certain special uses, for example on aircraft bearings and in bearings operating at abnormally high speeds. Current experimental work indicates that a substantial reduction in soap content should also be realized.

Such improvements should increase further the value of these complex barium soap greases for the purpose of general lubrication.

In the meantime, when a customer requests only one grease for a number of highly different services or wishes only one grease on his premises, the type of barium grease described in this paper is definitely the most satisfactory answer that one large grease manufacturer has been able to offer to date.

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Servicing Hydraulic Brakes

By EARL M. TABER
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Hydraulic brakes have been standard equipment on practically all makes of cars for a number of years. The hydraulic brake system used on Pontiac cars provides for the use of a special Delco fluid which is conducted through pipe lines, under pressure, to cylinders within each wheel brake drum assembly. A supply of the fluid is confined within a unit known as the master brake cylinder.

The brake shoes are brought into contact with the drums by hydraulic pressure developed in the master brake cylinder by pedal pressure and distributed to the brake assemblies equally by means of pipe lines. This hydraulic pressure is converted into movement at the wheel cylinders which expands the shoes with equal pressure on each side of the car.

When the brake pedal is depressed, the piston in the master cylinder forces the brake fluid out of the master cylinder, through the pipe lines and into the wheel cylinders, forcing the wheel cylinder pistons to move outward, expanding the brake shoes against the drums and taking up brake shoe clearances. This part of the brake action is accomplished with very light pressure on the pedal. The initial pedal movement is arrested when shoe clearances are taken up, and further pressure on the pedal produces correspondingly higher pressures within the hydraulic system and greater force is exerted against the brake shoes.

As the brake pedal is allowed to return to the released position, the hydraulic pres-

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specifications, both government and industrial, still carry this limitation. The requirements that the grease be of a given consistency, well made and free from fillers (all included in these same specs.) give ample assurance of the quality and suitability, but many a good grease fails to pass the specifications because the oil content is 1 or 2% low.

(3) *Ash Determination*

The ASTM procedure (D128-40) clearly states that an ash determination should not in general be regarded as of any great importance, but the method still occupies a prominent position and, because no better criterion is presented, it is frequently called for. What the user of any grease really needs to know is how much gritty matter is present in the grease, not how much calcium or sodium oxide was combined with fat to make the soap jelly.

The solution of the grease in a solvent which does not react with the mineral matter (such as Stoddard solvent containing 10% butyl cellosolve or a hot benzol-alcohol mixture) followed by filtering in a gooch crucible, will reveal the presence of undue amounts of unreacted lime, mineral impurities and all other non-lubricating solids. (If graphite is present, it can be removed by ignition of the residue on the filter). The ASTM method for fillers, in which the grease is broken up with HCL, does not show the presence of minerals soluble in acid, such as calcium carbonate, (whiting or unburned lime.) The Navy count of the dark specks visible in a sample on a microscope stage sometimes may report soft, harmless bodies as dirt, implied by the specifications to be harmful.

(4) *Water*

Water in a calcium soap grease need not be restricted to as low a figure as is frequently written. 2½ to 3% water thoroughly combined does no harm, in fact serves as a combining agent; it does not cause rusting because the water is the internal phase of a complex emulsion, each droplet surrounded by oil. Uncombined water which can be seen on a microscope slide is really harmful because each drop forms a weak spot in the lubricating film and any water which is not properly emulsified might contact the metal and cause rusting.

For these reasons, it is suggested that limits up to "3% water with no visible uncombined water" be permitted.

(5) *Oil Sweating (Separation)*

Methods of testing for the amount of oil which might separate from a grease in service have largely been based on the heating of a sample of grease in a perforated or wire-gauze cone. Since this test was introduced, there has been developed a tendency in the more lately issued specifications to increase the prescribed temperature in order to accelerate the test and to make it more severe. Variations of these test methods were discussed by Mr. Carl Georgi, Chairman of the Technical Committee, at the previous N.L.G.I. meeting. His tests showed, among other things, that at elevated temperatures all greases made from low viscosity oils showed too much sweating. Too high a test temperature hence might require a grease maker to use an oil which is too viscous for the conditions of service merely in order to pass a sweating test.

All lubricating greases should sweat a little free oil, to enable them to creep into narrow clearance by capillary action. All satisfactory greases now in service do sweat a little oil. It is not correct to assume that the grease which passes the most severe sweating test will give the best lubrication.

The cone test in some cases gives misleading results because some greases change their structure at elevated temperatures (aluminum soaps at about 160°F. for instance). Also, calcium soap greases lose water and separate at 160°F. in the cone, yet are satisfactory greases for the services recommended or for storage even in hot climates. Calcium soap greases are not recommended for use in conditions where outside sources of heat produce temperatures such as these.

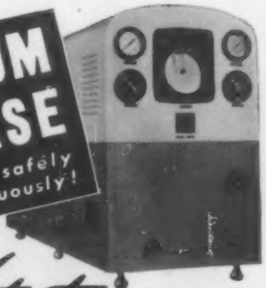
Greases which are recommended for use at elevated temperatures will give valuable information if cone-tested at these temperatures, but for calcium or aluminum soap greases, the 160° cone test is misleading.

(6) *Dropping Point in Relation to Temperature of Use.*

The ideal melting point determination would perhaps be one which gave a figure which could be used as a positive guide to the maximum safe operating temperature in service. Unfortunately, other factors such as surface speed, bearing clearance, time, and tightness of seal which affects the relative area of vapor disengaging surface, have an important bearing on how much heat a grease can withstand.

In service, sufficient softening may occur below the stated temperature to cause trouble. On the other hand, where seals are tight and other conditions favorable, certain sodium soap greases have been used successfully above their "melting point."

In the case of calcium soap greases, the drying action of a combination of temperature and time produces trouble which would not be expected from consideration of the temperature alone. Hence, if a No. 3 cup



grease gives trouble due to the unavoidable heat surrounding a bearing, no advantage is gained by calling for a No. 5 grease, which has distinctly higher dropping point; yet this has frequently been done.

Therefore, this ideal melting point figure is impossible of realization. We may as well face the fact that melting point or dropping point determinations are empirical things, correct only because they comply with an agreed definition, and that the method which is adopted by the largest number of the persons concerned automatically becomes the "best." Such a standard measure of the progressive softening which occurs when the temperature is raised gives valuable information as to the materials and workmanship used in making a grease, but this figure alone is not a measure of safe operating temperature.

(7) *Lubricating Ability*

It has sometimes been stated that the thickening of oils with soap merely puts the oil into a form where it can be conveniently and economically applied as a lubricant. Arvesan has shown that the viscosity of a grease at high rates of shear approaches that of the oil from which it was made. This turns out to be a remarkable advantage in favor of the use of grease in certain positions, releasing us from the fear of high internal losses due to a grease being too heavy for high speeds, but it has been interpreted by some as indicating that, after all, when we lubricate with grease, we only apply oil in a different form.

This is more or less true with regard to lubrication under perfect film conditions where a hydrodynamic pressure of lubricant can be built up by the fast rotating bearing, but it falls far short of stating the case in conditions where these requirements are not met.

We must go back to the fundamental distinction in lubrication theory between floating film conditions and broken film conditions, which cannot be emphasized too clearly.

In the first case, the motion of the journal tends to draw in lubricant faster than it can squeeze out at the ends of the bearing, and the chemical nature or oiliness of the lubricant is not important.

In the second case, where the speed is not high enough or steady enough, and in reciprocating parts or in misaligned bearings, such a cushion of lubricant cannot be depended upon, and metal-to-metal contact exists unless there is present a sufficient quantity of substances in the lubricant to form a protective film on the metal and resist being squeezed or scraped away. Small amounts of high molecular weight fats and fatty acids, also certain ketones, lactones and other polar compounds, have been found to produce the desired effect. Traces of soaps dissolved in oils, such as may occur in lubricating greases, also reduce the friction in this broken-film stage. We thus have two aids to better lubrication when using grease; the lubricant does not squeeze out so easily thus insuring "floating" conditions a larger proportion of the time, and, when the ideal fluid film cannot be maintained, the oil soap mixture has greater lubricating power.

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sure is relieved and the brake shoe retracting springs draw the shoes together, pressing the wheel cylinder pistons into the wheel cylinders and causing the brake fluid to flow back through the pipe lines and into the master cylinder.

Master Cylinder

The master brake cylinder seldom requires servicing. If improper functioning or leaky conditions occur, the repairing and any necessary adjustments should be done by an authorized Pontiac dealer.

The primary piston cup is retained against the piston and the check valve against its seat by pressure of the piston spring which returns the piston to the release stop faster than the brake fluid is returned through the pipe lines into the master cylinder, causing a small amount of fluid to flow through the holes in the piston and past the piston cup lip into the space ahead of the piston. When the piston is in a fully released position the compensating port is opened, and excess fluid returns to the reservoir as the brake shoe retracting springs force the fluid out of the wheel cylinders. The secondary cup prevents leakage of fluid into the boot and the check valve retains a slight pressure in the pipe lines and wheel cylinders to prevent possible entrance of air into the hydraulic system.

The fluid leaves the master cylinder by passing through holes in the check valve retainer and past the lip of the rubber cup, returning by lifting the check valve off its seat at the end of the cylinder against the pressure of the piston return spring.

Bleeding Hydraulic Brakes

The "bleeding" of the hydraulic brake system means removing any air that may be trapped in the system. This is a service that can be rendered by any wide awake

service station. The system must be bled every time a pipe line has been disconnected or whenever a leak has allowed air to enter the system in any manner. Air in the system is usually evident through the presence of a "spongy" brake pedal. Air trapped in the system is compressible and increases the pedal travel, sometimes to the extent that the pedal can be pressed to the floor. The system must be absolutely free from air at all times.

To bleed air from the system, proceed as follows:

1. Carefully clean all dirt from around the master cylinder filler plug.
2. Remove fill plug.
3. Fill the master cylinder full.
4. Starting with left front wheels, remove the cap screw from the bleeder valve and attach drain tube, allowing the tube to hang in a clean quart glass jar.
5. Unscrew the bleeder valve three-quarters of a turn.
6. Depress the brake pedal a full stroke, slowly, and allow it to return slowly, keeping the end of the bleeder tube under the surface of the liquid in the jar.
7. Continue operating the brake pedal, keeping the master cylinder full (so no air will enter the system).
8. Continue "7" until liquid containing no air bubbles emerges from the bleeder tube.
9. Close the bleeder valve securely.
10. Remove bleeder tube and replace cap screw.
11. Repeat above procedure, one brake at a time, on right front, left rear, and right rear in the order given.
12. When bleeding operation is completed, refill the master cylinder to within ½ in. from top of fill plug hole. Replace plug.
13. It is poor economy to attempt to clean used fluid. To avoid trouble it should be thrown away.

Do not take chances on unknown brands of hydraulic fluids. Use only fluids recommended by the car manufacturer. If fluid has been seeping past the wheel cylinder pistons and forming a sticky rim around the cylinders, it is evidence that an improper fluid has been used or that the piston cups need replacing. When this condition is found, the brake system should be examined for gummed or scored pistons and cylinders.

In the event that an improper fluid has entered the system, it will be necessary to flush out the system and possibly to replace all rubber parts, including the brake hoses.

Editor's Note: While this article was written for Pontiac cars, instructions for bleeding the hydraulic brake system will apply in general to other makes of cars.